Author
L. B. Hagler/ C. A. Corradi

Checked by
J. P. Zbasnik
Jon Zbasnik

Department
Mechanical Engineering

Date
7/11/02

MAG

Program - Project - Job: **US – LHC DFBX**

Title: **Thrust Load Bumper Bracket, Anchor Bolt, and Stand-off Stress Analysis**

INTRODUCTION

This report details the stress analysis performed on the thrust load bumper bracket, its anchor bolts, and thrust pad and stud stand-offs shown in LBNL drawing 25I166. These components are designed to withstand thrust loads imposed on the DFBX vacuum vessel by vacuum loading from the LQX and cryogenic piping pressure loads.[1] The thrust pad/grub screw transfer the thrust load imposed on the DFBX to the bumper brackets and eventually to the LHC tunnel floor. The adjustable grub screws allow repositioning of the DFBX in the beam-axis direction without any change in the bracket locations. The stand-off thrust pad butts-up against the DFBX with the stud end threaded into the bumper bracket.

Hilti Model HSL M24/60 expansion anchors are recommended for attaching the brackets to the LHC concrete floor. The loading induces bending and direct shear stresses in the bracket and causes a combination prying and shearing action on the bolts. It is shown that the bracket design, stand-offs, and anchor bolt specification are adequate to withstand the design loads with acceptable safety margin.

DISCUSSION

Bracket

Three bumper brackets are abutted against the DFBX box to stabilize it against the resultant thrust load. Figure 1 is a diagram showing the placement of the bumper brackets relative to the DFBX and its mounting jacks. There is one bracket and two mounting jacks at the LBX, and at the LQX there are two brackets and one mounting jack. For this analysis, it is assumed that the jacks provide no restraint and only one bracket reacts the entire thrust load.

Figure 2 is a sketch of the bumper bracket. The bumper bracket material is type 304 stainless steel (SA-240), which has a minimum yield strength of 30 ksi and minimum ultimate tensile strength of 75 ksi. The ASME code allowable is 18.8 ksi. The loading of the bracket was calculated in a previous Engineering Note[2]. It was calculated there that the vacuum thrust load is 15 kips, while the overpressure load is 10 kips. Therefore, the vacuum thrust load controls the bumper bracket design and anchor bolt specification. It is

[1] M8038 DFBX vacuum vessel structural analysis gives a description of the vacuum/pressure thrust loads and the resultant load the bumper bracket must restrain.
[2] Ibid.

assumed that the thrust load is concentrated on the bracket at the tip of the span for the bracket stress calculations.

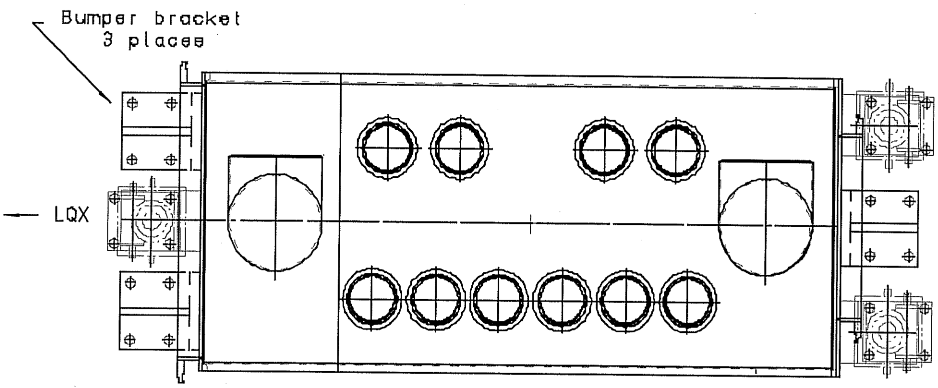


Figure 1. Bumper Bracket Arrangement Relative to DFBX

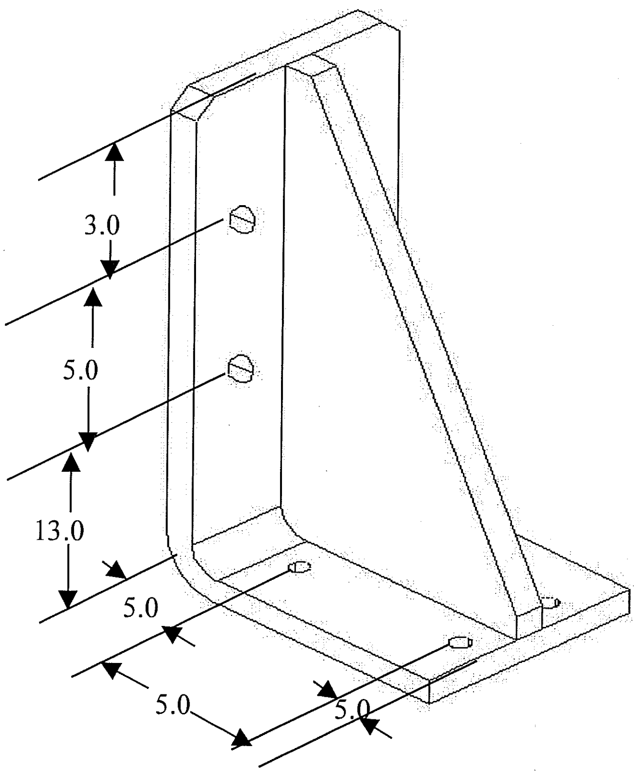


Figure 2. Sketch of Bumper Bracket (See drawing 25I166 for details.)

Floor Anchor Bolts

Figure 2 shows two holes on either side of the web on the base of the bracket. It is conservatively assumed that one bolt on each side is load bearing, these being the bolts farther from the load application. It is also assumed that the concrete flooring/anchor bolt connection is made according to the manufacturer's specification to withstand the pullout forces of these bolts. These forces are tabulated in Table I in the result section.

Anchor bolt specifications:

Manufacturer: HILTI
HSL Heavy-Duty Expansion Anchor - M24/60
Min. embedment depth = 155 mm
Max. thickness fastened = 60 mm
Max. Tightening Torque = 525 ft-lbs
Allowable working load in tension = 9860 lbs
Allowable working load in shear = 17950 lbs
Ultimate tensile load = 34390 lbs
Ultimate shear load = 62615 lbs

Stand-off

The stand-off is designed to take the 15000 lb thrust load from the cryostat. The stand-off recommended for this application consists of a 4-inch diameter contact pad on the end of a 1-8 threaded stainless steel stud. The assembly is rated for a 20000-lb load. The stand-off assembly is made by International Equipment Components; details are included in the Appendix.

RESULTS

Bracket

Figures 3 and 4 are the shear and bending moment diagrams for the bracket. These diagrams show the shear force and bending moment at each cross-section of the bracket along its span with the assumption of static equilibrium (see sketches in the Appendix for clarification). Here x is the span-wise direction across the bracket surface abutted against the DFBX. Figure 5 shows the variation of maximum direct shear stress in the bracket cross-section along the span normalized by the yield strength of the material in shear. Figure 6 shows the variation of maximum compressive stress in the bracket cross-section along the span and Figure 7 shows the variation of maximum tensile stress in the bracket cross-section along the span, both normalized by the yield strength. The maximum shear stress always occurs at the neutral axis of the cross-section, while the maximum compressive stress occurs at the bottom of the web and the maximum tensile stress at the top of the flange for a given cross-section. Since the maximum shear and normal stresses occur at different locations of the cross-section, each stress can be evaluated separately. It can be seen from these figures that the largest stress ratio is 0.64 in compression (multiplying the graph value by a factor of 1.4 to account for the ASME allowable), giving a factor of safety equaling 1.6 against yielding. The maximum deflection of the bumper bracket under the 15 Kip thrust load on the tip of the span is 0.029 ins (0.74 mm). The details of the bumper bracket stress and deflection analysis can be found in the Appendix.

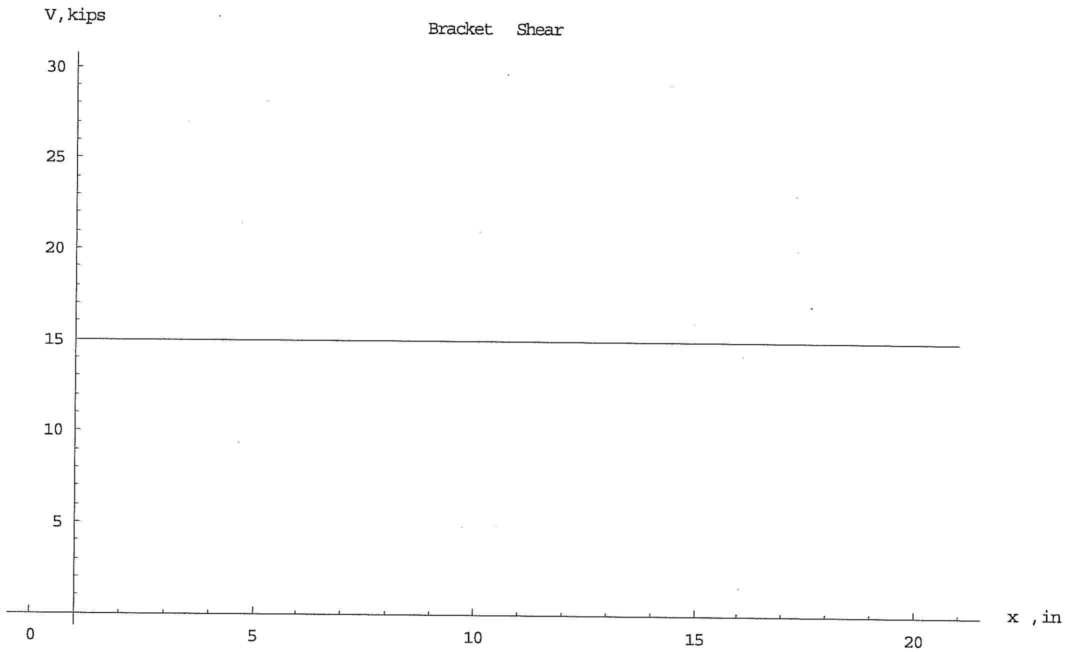


Figure 3. Shear Diagram for Thrust Bracket (Kips)

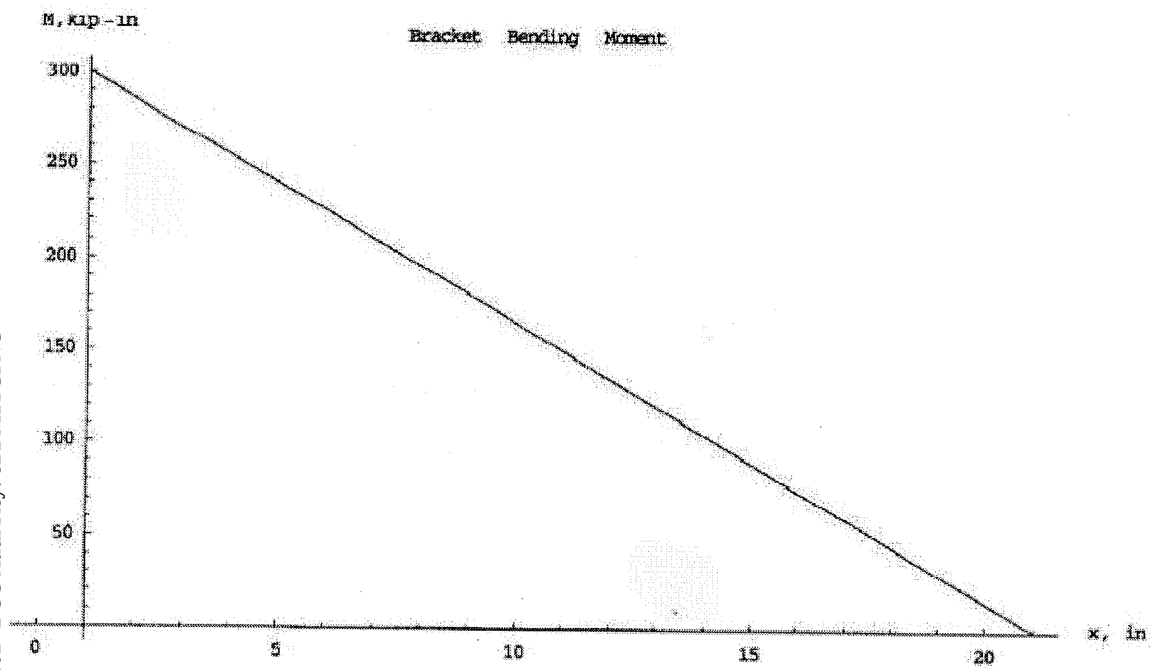


Figure 4. Bending Moment Diagram for Thrust Bracket (Kip-in.)

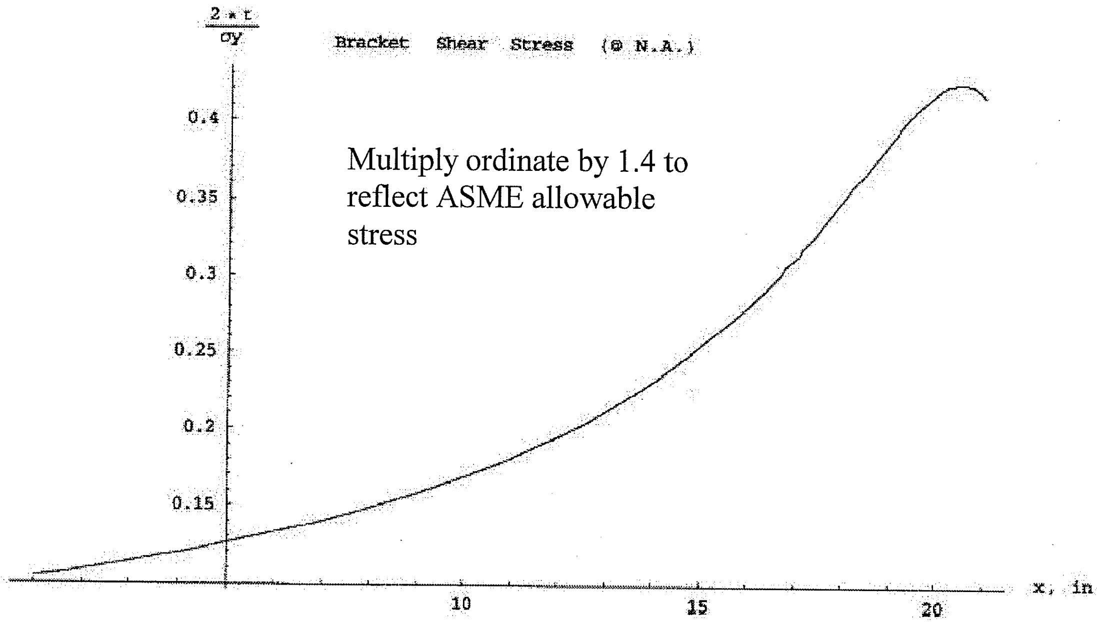


Figure 5. Maximum Shear Stress to Shear Strength Ratio Along Span of Thrust Bracket

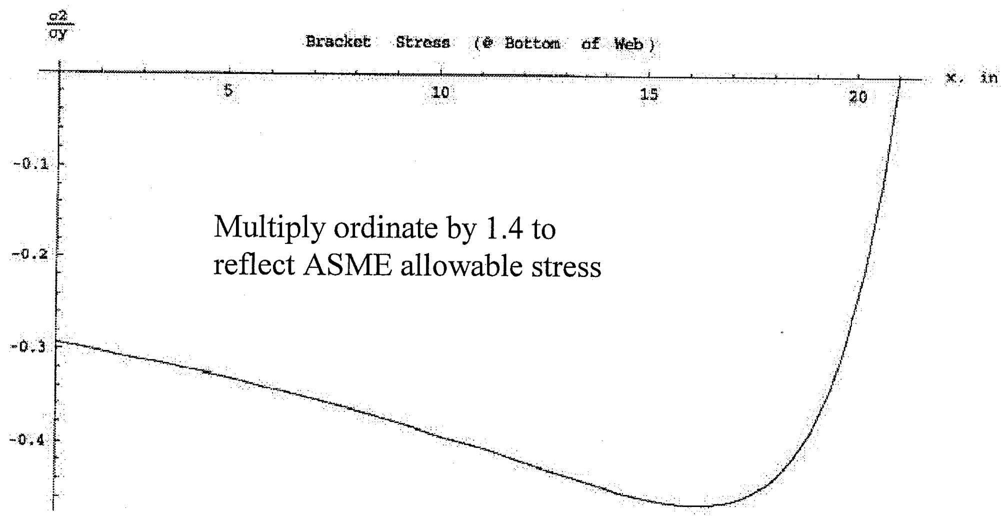


Figure 6. Maximum Compressive Bending Stress to Yield Strength Ratio Along Span of Thrust Bracket

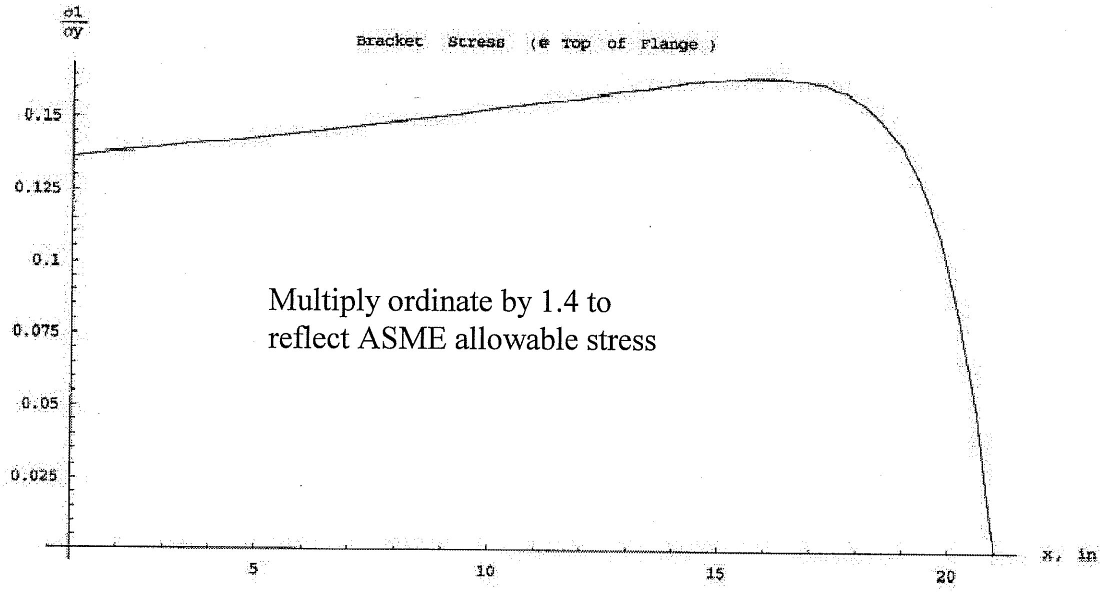


Figure 7. Maximum Tensile Bending Stress to Yield Strength Ratio Along Span of Thrust Bracket

Bolts

Heavy-duty M 24/60 expansion anchors satisfy the load requirements of the bracket pull-out and shear loads. It is assumed that only two of the four bolts carry the vacuum thrust load. The bolt loads and safety factors are listed in Table I.

Table I

Bolt Load Analysis Results
Bolt Prying Force = 6.6 e3 lbs. (2.93 e4 N); F. S. = 9.86e3/6.6e3 = 1.5
Bolt Shear Load = 7.5e3 lbs. (3.33e4 N); F. S. = 17.95e3/7.5e3 = 2.4

Stand-Off

The stand-off and stud assembly have a rated load capacity of 20000 lbs. Since it is conservatively assumed that the full thrust load will be shared by two of the four assemblies, this represents a safety factor of 2.7.

CONCLUSION

It has been shown that the current bumper bracket design, stand-offs, and bolt specification are able to withstand the thrust load (and, by comparison, the vacuum vessel over-pressure) with adequate safety margins.

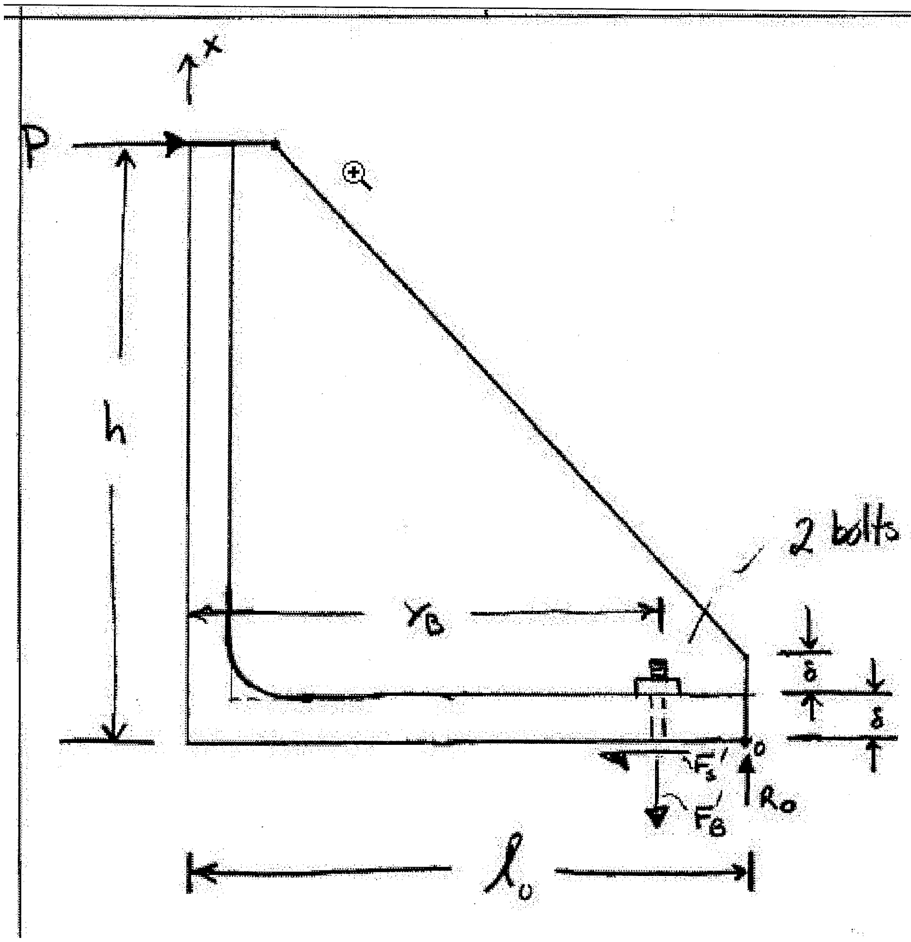
REFERENCES

1. Shigley ,J.E. and Mitchell,L.D., *Mechanical Engineering Design*,4th Edition, McGraw-Hill,1983
2. ASME B&PV Code 1998, Section I, Division VIII
3. Corradi, C.A., LBL Engineering Note Code-LH 20 01, Serial # M8038, 2001

APPENDIX

<u>SHEAR AND BENDING MOMENT CALCULATIONS</u>

δ = 1.000 in
ℓ_o =
h = 20.991 in
Y_B = 10 in.



$$\Sigma F_x = R_o - F_B' = 0$$

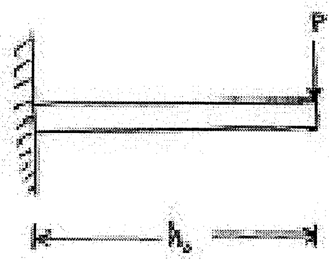
$$\Sigma F_y = P - F_S' = 0$$

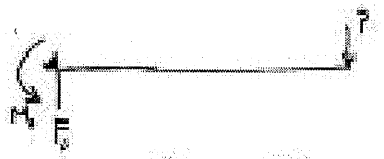
$$\Sigma M_o = Ph - F_B'(l_o - y_B) = 0$$

$$\therefore \boxed{F_B = \frac{1}{2}\left(\frac{h}{l_o - y_B}\right) P}$$

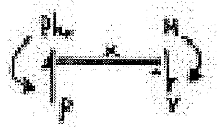
$$\therefore \boxed{F_S = \frac{1}{2} P}$$

$h_o = h - s$

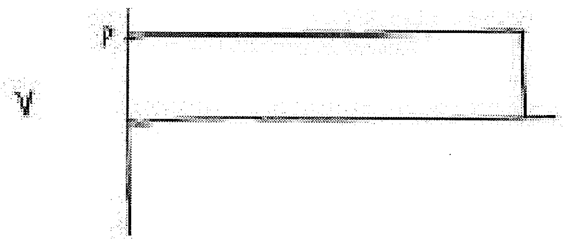


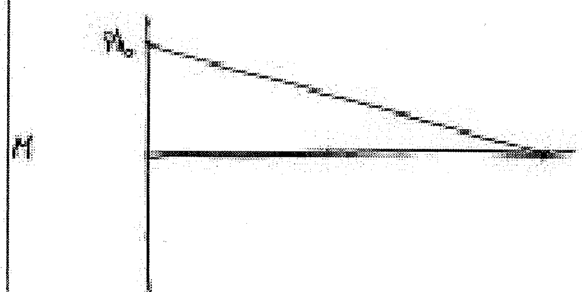


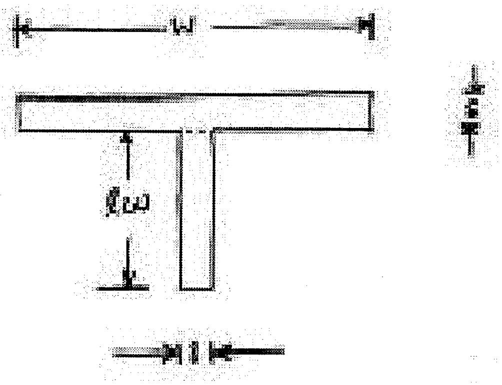
$\Sigma F = F_y - P = 0$
$\Sigma M = M_o - Ph_o = 0$



$\Sigma F = P - V = 0$
$\Sigma M = M + Px - Ph_o = 0$
$M = P(h_o - x)$



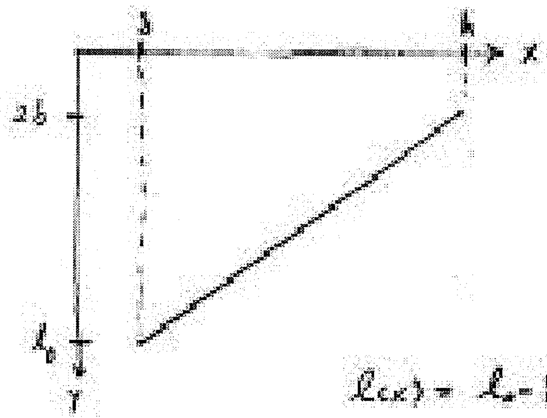




$$\bar{y} = \frac{w\delta(\ell(x) + \frac{1}{2}\delta) + \ell(x)\delta(\frac{1}{2}\ell)}{w\delta + \ell(x)\delta} = \frac{w\ell + \frac{1}{2}w\delta + \frac{1}{2}\ell^2}{w + \ell}$$

$$\rightarrow \quad \bar{y} = \frac{w(2\ell + \delta) + \ell^2}{2(w + \ell)}$$

$$\rightarrow \quad I(x) = \frac{1}{12}\delta\ell^3 + \ell\delta(\bar{y} - \frac{\ell}{2})^2 + \frac{1}{12}w\delta^3 + \delta w(\ell + \frac{\delta}{2} - \bar{y})^2$$



$$\ell(x) = (\frac{2\delta - \ell_0}{h - \delta})x + \frac{\ell_0 h - 2\delta^2}{h - \delta} - \delta$$

$$\ell(x) = \ell_0 - \delta, \quad 0 \le x \le \delta$$

$$\ell(x) = (\frac{2\delta - \ell_0}{h - \delta})x + (\frac{\ell_0 h - 2\delta^2}{h - \delta}) - \delta, \quad \delta \le x \le h$$

$$\sigma_1 = \frac{M(x)\,(L(x)+\delta-\bar{y})}{I(x)} \quad \text{(Top of Flange)}$$

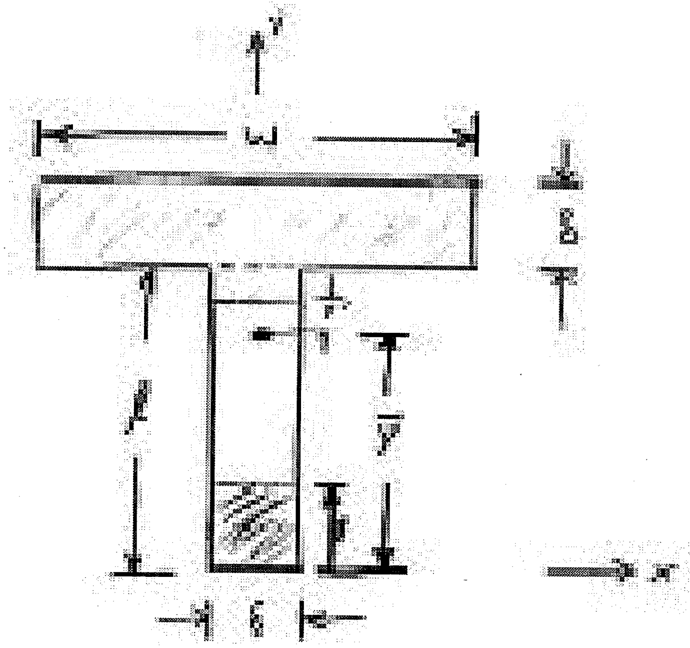
$$\sigma_2 = -\frac{M(x)\,\bar{y}}{I(x)} \quad \text{(Bottom of web)}$$

$$\tau_{max_1} = \frac{V(x)\,\bar{y}^2\,\delta}{2\,I(x)\,\delta} = \frac{V(x)\,\bar{y}^2}{2\,I(x)}, \quad \delta \le x \le x_L \quad \text{(neutral axis)}$$

$$\tau_{max_2} = \frac{V(x)}{2\,I(x)}\left(\bar{y}^2-(\bar{y}-l)^2\right), \quad x \ge x_L \quad \text{(Top of web)}$$

BRACKET SHEAR AND DEFLECTION

$\underline{x \le x_L}$:



$$\tau = \frac{VQ}{It} \quad , \quad \begin{array}{lll} t = s & \text{if} & \bar{y} \le \ell \\ t = w & \text{if} & \bar{y} \ge \ell \end{array}$$

$$Q_1 = \int_y^{\bar{y}} y\,dA = s\int_y^{\bar{y}} y\,dy = \tfrac{1}{2} s(\bar{y}^2 - y^2)$$

$$Q_2 = \int y'\,dA \quad , \quad y' = y - \bar{y} \quad ; \quad dy' = dy \quad ; \quad dA_1 = s\,dy \quad ; \quad dA_2 = w\,dy$$

$$Q_2 = s\int_{y'}^{\ell-\bar{y}} y'\,dy' + w\int_{\ell-\bar{y}}^{\ell+b-\bar{y}} y'\,dy' = \tfrac{1}{2} s\left((\ell-\bar{y})^2 - (y-\bar{y})^2\right) + \tfrac{1}{2} w\left((\ell+b-\bar{y})^2 - (\ell-\bar{y})^2\right)$$

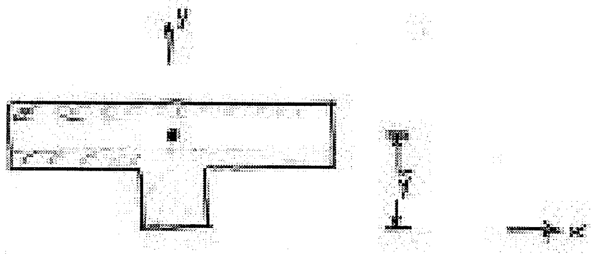
$$Q_3 = w\int_{y'}^{\ell+b-\bar{y}} y'\,dy' = \tfrac{1}{2} w\left((\ell+b-\bar{y})^2 - (y-\bar{y})^2\right)$$

$$\tau = \frac{V(\bar{y}^2 - y^2)}{2I} \quad , \quad 0 \le y \le \bar{y}$$

$$\tau = \frac{V}{2I}\left(\left((\ell-\bar{y})^2 - (y-\bar{y})^2\right) + \frac{w}{s}\left((\ell+b-\bar{y})^2 - (\ell-\bar{y})^2\right) \right) \quad , \quad \bar{y} < y \le \ell$$

$$\tau = \frac{V}{2I}\left((\ell+b-\bar{y})^2 - (y-\bar{y})^2\right) \quad , \quad \ell < y \le \ell+b$$

$x > x_c$:



$$Q_1 = w\int_y^{d+b} y\,dy = \frac{1}{2}w\left((d+b)^2 - y^2\right)$$

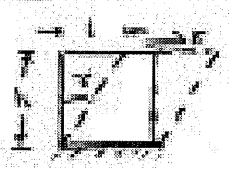
$$Q_2 = w\int_d^{\bar y}(\bar y - y)\,dy + \delta\int_y^{d}(\bar y - y)\,dy = \frac{1}{2}\left(w\left((\bar y-d)^2-(\bar y-y)^2\right) + \delta\left(\bar y^2-(\bar y-d)^2\right)\right)$$

$$Q_3 = \delta\int_0^{y}(\bar y - y)\,dy = \frac{1}{2}\delta\left(\bar y^2 - (\bar y - y)^2\right)$$

$$\tau = \frac{V}{2I}\left((d+b)^2 - y^2\right), \quad y \ge \bar y$$

$$\tau = \frac{V}{2I}\left(\left((\bar y-d)^2-(\bar y-y)^2\right)+\left(\frac{\delta}{w}\right)\left(\bar y^2-(\bar y-d)^2\right)\right), \quad d < y \le \bar y$$

$$\tau = \frac{V}{2I}\left(\bar y^2 - (\bar y - y)^2\right), \quad y \le d$$



$$\gamma = \frac{F}{AG}, \quad \tan\gamma = \frac{\delta}{h} \rightarrow \gamma = \frac{\delta}{h}$$

$$\delta = \frac{Fh}{AG} \rightarrow k_s = \frac{AG}{h}$$

$$U = \frac{1}{2}k_s\delta^2 = \frac{1}{2}\left(\frac{AG}{h}\right)\left(\frac{Fh}{AG}\right)^2 = \frac{1}{2}\frac{F^2h}{AG}$$

$$U = \frac{1}{2}\frac{(\tau A)^2h}{AG} = \frac{\tau^2}{2G}Ah = \frac{\tau^2 v}{2G}$$

$$\frac{U}{v} = \frac{\tau^2}{2G} = u$$

$$dU = u\,dv \rightarrow dU = \delta\left(\frac{\tau^2}{2G}\right)dx\,dy$$

$$dU = \left(\frac{\delta\,dx}{2G}\right)\tau^2 dy \rightarrow dU = \frac{\delta\,dx}{2G}\int\tau^2 dy$$

$x \le x_c$:

$$dU = \left(\frac{\delta\,dx}{2G}\right)\left(\frac{V}{2I}\right)^2\left\{\delta\int_0^{\bar y}\left(\bar y^2 - y^2\right)dy + \delta\int_{\bar y}^{d}\left[\left((d-\bar y)^2-(y-\bar y)^2\right)+\left(\frac{w}{\delta}\right)\left((d+b-\bar y)^2-(d-\bar y)^2\right)\right]^2dy + w\left(\frac{w}{\delta}\right)^2\int_d^{d+b}\left((d+b-\bar y)^2-(y-\bar y)^2\right)^2dy\right\}$$

$$dU_{bending} = \frac{M^2}{2EI}dx = \frac{P^2(L-x)^2}{2EI}dx$$

$x > x_E$:

$$dU_{shear} = \left(\frac{dx}{8G}\right)\left(\frac{P}{EI}\right)^2 \left\{ w \int_{\bar{y}}^{d+t} \left((d+t)^2 - y^2\right)^2 dy + b \int_0^{d} \left(\bar{y}^2 - (\bar{y}-y)^2\right)^2 dy \right.$$

$$\left. + w \int_{d}^{\bar{y}} \left[\left((\bar{y}-d)^2 - (\bar{y}-y)^2\right) + \left(\frac{b}{w}\right)\left(\bar{y}^2 - (\bar{y}-d)^2\right) \right]^2 dy \right\}$$

$$dU_{bending} = \frac{P^2 (h-x)^2}{2EI} dx$$

$$U = U_{shear} + U_{bending}$$

$$\Delta = \frac{\partial}{\partial P} \int_0^h d\left(U_{shear} + U_{bending}\right)$$

Let $\{\cdots\}_1 = Q_1(x)$ & $\{\cdots\}_2 = Q_2(x)$

$$\therefore \quad \Delta = \int_0^{x_E} \left(\frac{P Q_1(x)}{4 G I_{xx}^2} + \frac{P (h-x)^2}{E I_{xx}} \right) dx + \int_{x_E}^{h} \left(\frac{P Q_2(x)}{4 G I(x)^2} + \frac{P (h-x)^2}{E I(x)} \right) dx$$

EQUATIONS FOR SHEAR, MOMENT, AND STRESS PLOTS

In[1]:=

$$h = 20.991;$$
$$\delta = 1.000;$$
$$l0 = 10.381;$$
$$w = 8.000;$$
$$yb = 3.035;$$
$$P = 15.0;$$
$$Es = 30 * 10\,^\wedge 6;$$
$$vs = 0.30;$$
$$Gs = \frac{Es}{2 * (1 + vs)};$$
$$l = -\delta + \left(\frac{l0 * h - 2 * \delta^2}{h - \delta}\right) - \left(\frac{l0 - 2 * \delta}{h - \delta}\right) * x;$$
$$ybar = \frac{w * (2 * l + \delta) + l^2}{2 * (w + l)};$$
$$sol = x\ /.\ Solve[l - ybar == 0,\ x][[1]];$$
$$V = P;$$
$$M = P * (h - x);$$
$$Icross = \frac{1}{12} * (\delta * l^3 + w * \delta^3) + \delta * l * \left(ybar - \frac{l}{2}\right)^2 + \delta * w * \left(l + \frac{\delta}{2} - ybar\right)^2;$$
$$s1 = \frac{M * (l + \delta - ybar)}{Icross};$$
$$s2 = -\frac{M * ybar}{Icross};$$
$$\tau 1 = \frac{V * ybar^2}{2 * Icross};$$
$$\tau 2 = \frac{V * \left[(ybar - l)^2 * \left(1 - \left(\frac{\delta}{w}\right)\right) + \left(\frac{\delta}{w}\right) * ybar^2\right]}{2 * Icross};$$
$$\tau 3 = \frac{V * (ybar^2 - (ybar - l)^2)}{2 * Icross};$$

```
σy = 39;
Plot[V, {x, δ, h}, AxesLabel → {"x ,in", "V,kips"}, PlotLabel → "Bracket Shear", AxesOrigin →
Plot[M, {x, δ, h}, AxesLabel → {"x, in", "M,kip-in"}, PlotLabel → "Bracket Bending Moment", A
pl1 = Plot[2 * τ1 / σy, {x, δ, sol},
  AxesLabel → {"x,  in", "2*τ/σy"}, PlotLabel → "Bracket Shear Stress (@ N.A.)", PlotRange → Al
pl2 = Plot[2 * τ3 / σy, {x, sol, h},
  AxesLabel → {"x,  in", "2*τ/σy"}, PlotLabel → "Bracket Shear Stress (@ N.A.)", PlotRange → Al
Show[pl1, pl2]
Plot[s2 / σy, {x, δ, h}, AxesLabel → {"x,  in", "σ2/σy"},
 PlotLabel → "Bracket Stress (@ Bottom of Web)", PlotRange → All, AxesOrigin → {δ, 0}]
Plot[s1 / σy, {x, δ, h}, AxesLabel → {"x,  in", "σ1/σy"},
 PlotLabel → "Bracket Stress (@ Top of Flange)", PlotRange → All, AxesOrigin → {δ, 0}]
```

$$\text{int1} = \delta * \int_0^{\text{ybar}} (\text{ybar}^2 - y^2)^2\, dy + \delta * \int_{\text{ybar}}^1 \left(((1-\text{ybar})^2 - (y-\text{ybar})^2) + \left(\frac{W}{\delta}\right) * ((1+\delta-\text{ybar})^2 - (1-\right.$$

$$W * \left(\frac{W}{\delta}\right)^2 * \int_1^{1+\delta} ((1+\delta-\text{ybar})^2 - (y-\text{ybar})^2)^2\, dy;$$

$$\text{int2} = W * \int_{\text{ybar}}^{1+\delta} ((1+\delta)^2 - y^2)\, dy +$$

$$W * \int_1^{\text{ybar}} \left(((\text{ybar}-1)^2 - (\text{ybar}-y)^2) + \left(\frac{\delta}{W}\right) * (\text{ybar}^2 - (\text{ybar}-1)^2) \right)^2 dy + \delta * \int_0^1 (\text{ybar}^2 - (\text{ybar}-y)$$

$$\text{u1} = \left(\frac{P}{4 * \text{Gs} * \text{Icross}^2}\right) * \text{int1};$$

$$\text{u2} = \left(\frac{P}{4 * \text{Gs} * \text{Icross}^2}\right) * \text{int2};$$

$$\text{u3} = \frac{P * (h-x)^2}{\text{Es} * \text{Icross}};$$

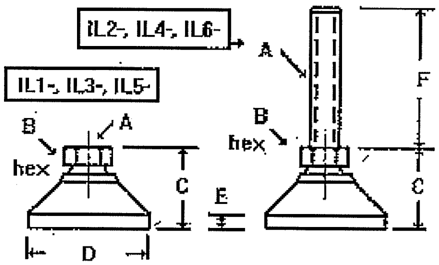
```
Δ = 1000.0 * (NIntegrate[u1 + u3, {x, δ, sol}] + NIntegrate[u2 + u3, {x, sol, h}]);
```

STAND-OFF ASSEMBLY DATA SHEETS

INTERNATIONAL EQUIPMENT COMPONENTS

2201 E. Willow St. #D-104, Signal Hill, CA 90806-2142
Phone: 562-597-4533, Fax: 562-498-2275
http://www.fia.net/la/sms e-mail: sms@fia.net

These steel, delrin, and stainless leveling feet are used to level and stabilize cabinets and equipment. The heat-treated stud and ball swivels 15° from centerline. Available in gold iridite zinc or black oxide finish (use B instead of G). An optional elastomer pad (Add -P) or cork pad (add -K) provides minor isolation protection, a non-marring surface and improved footing (1/8" thick) [Reduce load rating by 25%]. Also available in metric!



Socket Type P/N	Stud Type P/N	LOAD RATING	STEEL A	INCHES B	C	D	E	F
IL1-6G	IL2-6G	3000 lb	3/8-16	5/8	7/8	1-1/4	3/16	2
	IL2-6G7*	3000 lb	1/2-13	5/8	7/8	1-1/4	3/16	2
	IL2-6G8*	3000 lb	5/8-11	5/8	7/8	1-1/4	3/16	2
IL1-7G	IL2-7G	5000 lb	1/2-13	3/4	1-1/8	1-7/8	1/4	2
	IL2-7G8*	5000 lb	5/8-11	3/4	1-1/8	1-7/8	1/4	2
	IL2-7G9*	5000 lb	3/4-10	3/4	1-1/8	1-7/8	1/4	2
IL1-8G	IL2-8G	6000 lb	5/8-11	7/8	1-1/4	2-1/2	5/16	2
	IL2-8G9*	6000 lb	3/4-10	7/8	1-1/4	2-1/2	5/16	2
IL1-9G	IL2-9G	8000 lb	3/4-10	1-1/16	1-1/2	3	1/2	2 or 9**
	IL2-9G10*	8000 lb	3/4-10	1-1/16	1-1/2	3	1/2	2
IL1-10G	IL2-10G	20000 lb	1-8	1-1/2	1-7/8	4	13/32	4-1/4
			DELRIN®					
IL3-6W	IL4-6W	300 lb	3/8-16	5/8	7/8	1-1/4	3/16	2
	IL4-6W7*	300 lb	1/2-13	5/8	7/8	1-1/4	3/16	2
	IL4-6W8*	300 lb	5/8-11	5/8	7/8	1-1/4	3/16	2
IL3-7W	IL4-7W	700 lb	1/2-13	3/4	1-1/8	1-7/8	1/4	2
	IL4-7W8*	700 lb	5/8-11	3/4	1-1/8	1-7/8	1/4	2
	IL4-7W9*	700 lb	3/4-10	3/4	1-1/8	1-7/8	1/4	2
IL3-8W	IL4-8W	1200 lb	5/8-11	7/8	1-1/4	2-1/2	5/16	2

	IL4-9W10*	1800 lb	1-8	1-1/16	1-1/2	3	1/2	2
IL3-10W	IL4-10W	2400 lb	1-8	1-1/2	1-7/8	4	13/32	4-1/4
			STAINLESS					
IL5-6	IL6-6	3000 lb	3/8-16	5/8	7/8	1-1/4	3/16	2
	IL6-67*	3000 lb	1/2-13	5/8	7/8	1-1/4	3/16	2
	IL6-68*	3000 lb	5/8-11	5/8	7/8	1-1/4	3/16	2
IL5-7	IL6-7	5000 lb	1/2-13	3/4	1-1/8	1-7/8	1/4	2
	IL6-78*	5000 lb	5/8-11	3/4	1-1/8	1-7/8	1/4	2
	IL6-79*	5000 lb	3/4-10	3/4	1-1/8	1-7/8	1/4	2
IL5-8	IL6-8	6000 lb	5/8-11	7/8	1-1/4	2-1/2	5/16	2
	IL6-89*	6000 lb	3/4-10	7/8	1-1/4	2-1/2	5/16	2
IL5-9	IL6-9	8000 lb	3/4-10	1-1/16	1-1/2	3	1/2	2
	IL6-910*	8000 lb	1-8	1-1/16	1-1/2	3	1/2	2
IL5-10	IL6-10	20000 lb	1-8	1-1/2	1-7/8	4	13/32	4-1/4
**	IL2-9G-9	4000 lb	3/4-10	1-1/16	1-1/2	3	1/2	9

Delrin is a registered trademark of Dupont Corporation.

TOP OF SITE

NEW! Low Profile Swivel Levelers. Lower weight, cost and height. This design allows you to lower the center of gravity of your equipment (for OSHA) and has a special ball design which reduces ball and base separation. It also allows you to recess the casters into your equipment and not worry about the feet hitting when rolling over door sills and up ramps. Also available with an optional **.59" diameter lag hole** (Add -H) (1-7/8" diameter base and larger). **An IEC exclusive!**

To order stainless, replace G with S in the P/N.

To order 4" thread length (add X4)